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Research Article

The Association of Regular Exercise with Violence Related Behaviors in Urban Adolescents

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Abstract

Objective: Is regular exercise in urban adolescents associated with decreased violence related behaviors.

Methods: Cross-sectional secondary analysis of a New York City public high school survey. The exercise exposure variables identified were: Exercise frequency, # sit-ups, longest run, playing on a sports team. The violence related behavior outcome variables were: *Not* carrying a weapon, *not* being in a physical fight, *not* being in a gang. Logistic regression analysis was used to generate odds ratios between primary exposure and outcome variables.

Results: Females reporting higher exercise frequency had increased odds of *not* being in gang (2.9[1.6-5.2]). Females doing ≥ 20 sit-ups had increased odds of *not* carrying weapon (2.6[1.4-4.8]) and of *not* being in gang (2.5[1.4-4.6]). Females reporting running ≥ 20 minutes had increased odds of *not* carrying weapon (2.4[1.2-4.9]) and of *not* being in gang (2.3[1.2-4.6]). Females reporting being on a team had increased odds of *not* carrying weapon (2.0[1.1-3.6]), *not* being in fight (1.95[1.4-2.7]) and *not* being in gang (2.6[1.5-4.4]). Males reporting being on a team and higher exercise frequency had increased odds of *not* being in a fight (1.7[1.2-2.4]) and (1.5[1.1-2.0]).

Conclusions: Higher exercise frequency and intensity was associated with decreased violence related behaviors in females and only protective against fighting in males.

INTRODUCTION

Community violence results in significant morbidity, mortality, disability and suffering [1]. In addition, an estimated U.S \$17.4 billion are spent each year in direct and indirect costs related to gun related assaults and homicide including treatment of victims and incarceration of perpetrators [2-4]. The largest proportion of this cost to society (\$16.6 billion) results from lost productivity and direct medical costs (\$0.8 billion) [2-4]. Homicides disproportionately affect adolescents and young adults, racial and ethnic minorities and males, involved as both perpetrators and victims [5]. Homicide is the leading cause of death for young African-American males 15-24 years of age and the second leading cause of death for young Hispanic males of the same age range [5-7].

Factors that increase the risk of perpetration of violence include negative peer influences, family disruption and social isolation [1,8]. Studies have shown that juvenile crime peaks between the end of the school day and the time parents return from work (about 3-6 pm) [9,10]. These findings have led to an interest in increasing urban youth access to structured afterschool activities including participation and membership in team sports [11,12]. However, studies of interventions incorporating the

use of team sports have not consistently resulted in positive outcomes and only account for the effect of team sport exercise and not non-team sport exercise [13-15]. Nonetheless, in some studies team sports participants experienced improved short and long term academic and psychological functioning when compared to non-participants, while other studies found an increase in problem behavior [13-15].

In the studies where team sports was shown to decrease involvement in violence associated behaviors, it is unclear if the effect seen is secondary to being part of a team and the associated benefits of a positive peer group, or secondary to the exercise itself. Conceptual models suggest that regular exercise provides psychological benefits of increased self-esteem and reduced depression, tension and anxiety that may aid in violence prevention [16]. There is also evidence to suggest that regular exercise may help with the internalizing symptomatology of posttraumatic stress disorder (PTSD) and other anxiety and depressive symptoms experienced by youth exposed to violence [16-18]. To our knowledge, there are no reported studies investigating whether regular exercise, other than team sports, is associated with less violence related behaviors.

The objective of this study was to determine if exercise

frequency and intensity including participation in team sports, as reported by urban adolescent youth, is associated with decreased involvement in violence related behaviors. We hypothesized that adolescents reporting engagement in higher exercise frequency and intensity would report decreased involvement in the violence related behaviors.

METHODS

Study design

This cross sectional secondary study analyzed survey data from the Partners and Peers: Sexual and Dating Violence among New York City (NYC) Youth survey [19]. The survey was administered in 2006-2007 at four New York City Public High Schools, three in the borough of Manhattan and one in the borough of Brooklyn. Three of the schools had a predominant Hispanic population, while the fourth was predominantly African-American, and socioeconomic status in schools surrounding communities was not assessed in the initial survey. To assess for differences in community violence across the four schools, two questions were included in the original study as proxies for community violence that referred to missing school because you were afraid and being the victim of violent assault. The survey questions used in this analysis were all validated and adapted from the Youth Risk Behavior Survey (YRBS) and the Child Health Illness Profile-Adolescent Edition (CHIP-AE) [20,21]. The survey was administered anonymously in paper and pencil form in two schools and two other schools used an audio computer assisted version. Complete details of methods of the Partners & Peers study are available [19]. The original Partners & Peers study was approved by the Institutional Review Boards at Columbia University, St. Lukes-Roosevelt Hospital and the New York City Department of Education. The secondary analysis used in this study was reviewed and agreed to be exempt.

Measures

Exposure variables: Four survey questions related to exercise behaviors: "In the past 4 weeks on how many days did you exercise or play sports hard enough to make you breathe hard, make your heart beat fast, or make you sweat for 20 minutes or more?"; "In the past 4 weeks, how many sit-ups did you do the last time you did them?"; "In the past 4 weeks what is the longest time you ran without stopping?"; "In the past 12 months, how often did you play on a team that has a coach, other than in gym class?." Each question had a closed-ended response category. These responses were dichotomized as follows: exercise frequency in past 4 weeks (>10 days, <10 days), number of sit-ups in past 4 weeks (> 20 sit-ups, <20 sit-ups), longest run in past 4 weeks (> 20 minutes, <20 minutes), playing on a sports team in past 12 months (<1 time, >2 times).

Outcome variables: Three survey questions related to involvement in violence related behaviors: "During the past 30 days, on how many days did you carry a weapon such as a gun, knife, or club?"; "During the past 12 months, how many times were you in a physical fight?"; "At any time during the past 12 months, have you been a member of a gang?" [19]. Each question had a closed-ended response category (yes, no). These were then reverse coded to make them parallel to the direction of

the research question into the following outcome variables: *not* carrying a weapon in the past 30 days, *not* being in a physical fight in the last 12 months, *not* being a member of a gang in the last 12 months.

Statistical analysis

Because data exploration demonstrated that the relationships between exposures and outcomes differed systematically by sex, analyses were stratified by sex. Frequencies of each exercise predictor variable and violence behavior outcome variable were tabulated by sex. Pearson's Chi Square tests were used to test associations between exercise variables and violence-related behaviors stratified by sex.

Potential confounders selected based on prior literature included: age, race/ethnicity, having ever been pregnant (females)/ever having gotten someone pregnant (males), level of family engagement, and self-esteem. The level of family engagement represents a composite variable of three items derived from the CHIP-AE: (1) eating with family, (2) doing fun things with family, and (3) being listened to by family. The self-esteem variable was comprised of five items, also derived from the CHIP-AE: (1) feeling socially accepted, (2) feeling much to be proud about, (3) satisfied with life, (4) liking the way you are, and (5) feeling that you have a lot of good qualities. Two other potential confounders were selected and included the variables: missing school because you are afraid, and being threatened or injured with a weapon. These two variables were selected as potential confounders given that they were the only variables measured that could be used as a marker for the environmental influence of community violence on behavior.

Those confounders statistically associated with both the exposures and outcomes with a p-value <0.05 were included in separate logistic regression models comparing each of the three primary outcome variables and the four exposure variables. Crude unadjusted logistic regression models not including the confounders were also created separately. The unadjusted and adjusted odds ratios (OR) and corresponding confidence intervals (C.I) were then compared to assess for significant differences defined as a >10% difference between unadjusted and adjusted results.

Due to observed statistically significant differences between sex and the relationship between exercise and violence associated behaviors, all models were stratified by sex with stratum specific odds ratios generated to assess for effect modification by sex. Additionally, race/ethnicity was also significantly associated with a violence related behavior specifically the outcome "not being in a fight" as well as with the predictors, "exercise frequency" and "situps." Being threatened or injured with a weapon was associated with all three violent behavior outcomes and with the exercise predictor "team." These were therefore included in the appropriate adjusted logistic regression models and stratum specific point estimates by sex were compared to those from the unadjusted models. No significant >10% differences between any of the unadjusted and adjusted point estimates were noted, but the stratum specific unadjusted point estimates did differ from another, therefore the unadjusted stratum specific results stratified by sex are reported. Results can be found in table 3. No

other of the potential confounders listed prior met criteria for confounding and were thus not included in the final multivariate logistic regression models. SAS statistical software version 9.3 was used for all statistical analyses.

RESULTS

A total of 1,454 students participated and 1,312 completed the original Partners and Peers: Sexual and Dating Violence among NYC Youth survey anonymously (response rate of 70%). Table 1 lists demographic characteristics of participants. The sample consisted of more females (56%) than males and primarily Latino ethnicity (73%) (Table 1). Males compared to females reported significantly higher percentages of exercise frequency (31.9%, vs. 15.3%), sit-ups (37.1% vs. 16.8%), running (16.5% vs. 10.6%) and being part of a team (51.1% vs. 30.9%) (Table 2a, Figure 1). There was also significant sex-related differences in reported violent behavior outcomes, males reported lower percentages than females of not carrying a weapon (82.9% vs. 93.3%), not being in a fight (54.6% vs. 61.7%) and not being in a gang (83.2% vs. 92.3%) when compared to females (Table 2b, Figure 2).

Statistically significant associations between all four exposure variables and some of the primary outcome variables were found for females but significant associations were not consistent in males (Table 3). In females, each exercise variable was consistently associated with a two to three times increased odds of not having violence related behaviors (Table 3). Females reporting higher exercise frequency had 2.9 times the odds of *not* being in a gang. Females reporting doing > 20 sit-ups had 2.6 times the odds of *not* carrying a weapon and 2.5 times the odds of *not* being in a gang. Females who reported running > 20 minutes over past four weeks had 2.4 times odds of not carrying a weapon and 2.3 times the odds of not being in a gang. Females reporting being on a team had 2.0 times odds of *not* carrying a weapon, 1.95 times odds of *not* being in a fight and 2.6 times the odds of *not* being in a gang. Analyses resulted in only two significant associations among males: being on a team had 1.7 times the odds of *not* being in a fight and higher exercise frequency had 1.5 times the odds of *not* being in a fight.

DISCUSSION

These findings suggest that both exercise frequency and intensity, in addition to prior findings of team sports, may result in decreased violence related behaviors among urban adolescent females. However, even though the young males reported higher exercise frequency and intensity (>20 situps, >20minutes running) and participation in team sports when compared to females, there does not seem to be the same relationship between exercise and violence associated behaviors for them (Table 2a, and Table 3). The results of this study suggest that adolescent girls reporting exercising regularly had increased odds of not being involved in violence, with those girls reporting being part of a team having increased odds of avoiding all three violent related behavior outcomes. In adolescent boys, our study found that those individuals reporting regular exercise frequency and being part of a team had increased odds of not being in a fight in the previous year. No other significant associations were appreciated between any of the other exercise variables with the violent behavior outcomes in young males. Although the

Table 1: Study Sample Characteristics.

N	1312
% Female	56
% Latino	73
% Black	19
Age range (years)	13-19

association between exercise predictor variables and violence related outcomes were in a similar direction in both males and females, there was more significant associations observed in females. A potential explanation for the difference in statistically significant associations by sex is that aggression and violence may be more accepted in boys' high school sports than in girls' sports [9]. Thus, the promotion of aggression and violence in male sports may counteract the potential effects of increased exercise frequency, making it difficult for males to adjust their behavior outside of playing sports.

Potential mechanisms for the association of exercise and violence associated behavior reported here include the role of self-esteem, family engagement, the direct effect of exercise and the indirect effect of peer support when part of a group that exercises. However, in this study, there was no significant relationship between self-esteem or family engagement and violence related behaviors. The effect of exercise and its potential direct psychological benefits or the indirect effect of peer support remain as potential mechanisms to explain the relationship observed here. The variables and design of this study are not sufficient to differentiate between the direct effect of exercise and the indirect effect of peer support. The only variable that can be used as a proxy for peer support is the predictor variable being part of a team, however those individuals also potentially benefited from the direct effects of the exercise involved in participating in that particular team. The variables and design of this study are not sufficient to differentiate between the direct effect of exercise and the indirect effect of being part of a team, in those individuals participating in team sports. Furthermore, other predictor variables not particularly associated with being part of a peer group and that may be individualized (i.e., situps, running, exercise frequency), were also associated with some of the violence related behavior outcomes mainly in girls. However, we are unable to distinguish whether or not these exercises were done individually or in groups.

The new findings in our study suggest an additional role for the promotion of regular exercise and team sports in violence prevention for adolescent girls, but not strong enough evidence to support the use of such measures to deter violence associated behavior for adolescent males. However, urban youth often have limited options to exercise due to scarce community resources and may also experience a decrease in regular exercise because of reduced structured physical education in schools [22]. Recent Center for Disease Control and Prevention (CDC) data suggest that only 3.8 percent of elementary schools, 7.9 percent of middle schools and 2.1 percent of high schools provide daily structured physical education [22,23]. This decrease in regular exercise is concerning given the suggested potential psychological and physical benefits of exercise [16,17]. Given the observed

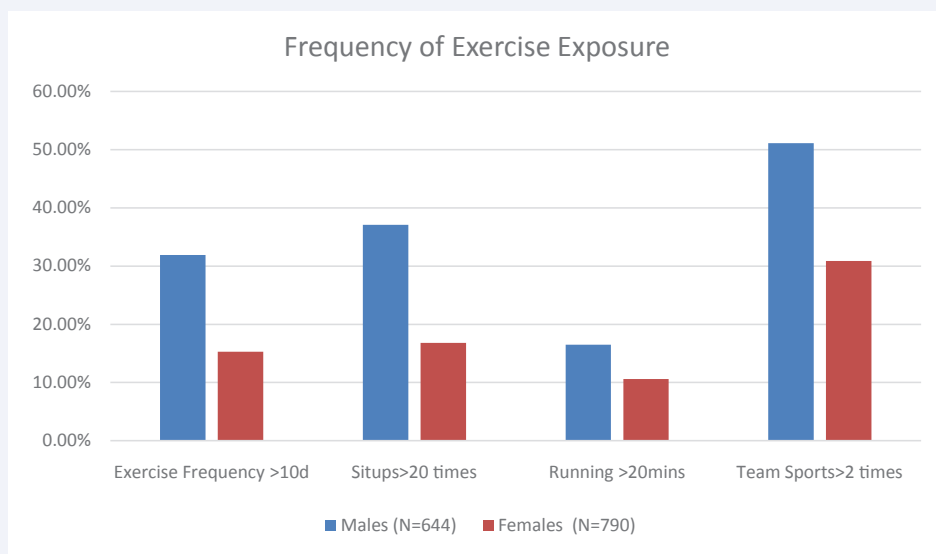


Figure 1 Frequency of Exercise Exposure In last 4 weeks by Sex.

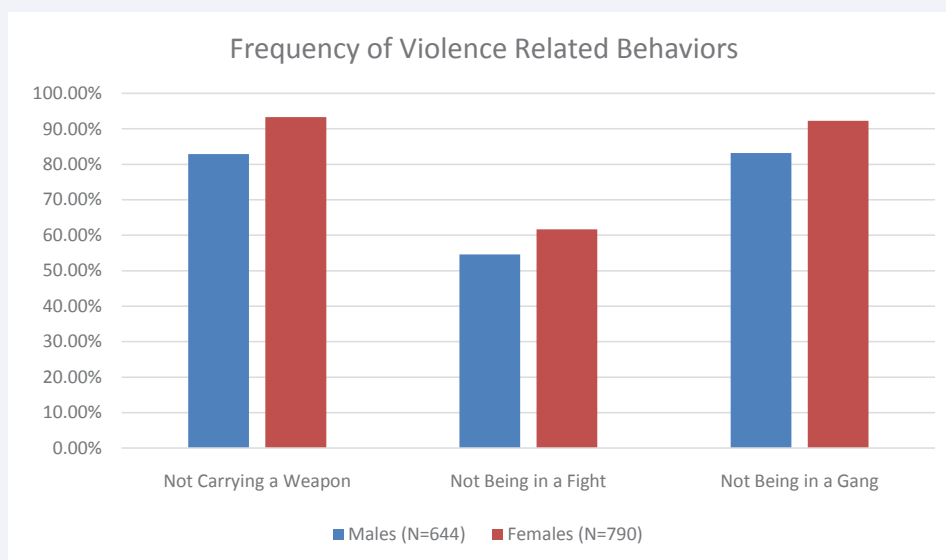


Figure 2 Frequency of Violence Related Behaviors in Last 30 Day by Sex.

Table 2a: Frequency of Exercise Exposure In last 4 weeks by Sex.

	Exercise Frequency >10 days	Situps >20 times	Running >20 minutes	Team Sports >2 times
Male (N=644)	31.9%	37.1%	16.5%	51.1%
Female (N=790)	15.3%	16.8%	10.6%	30.9%
Chi sq-value, p-value	56.0, <.001	75.9, <.001	10.5, .001	51.0, <.001

Table 2b: Frequency of Violence Related Behaviors in Last 30 Day by Sex

	Not carrying a weapon	Not being in a fight	Not being in a gang
Male (N=644)	82.9%	54.6%	83.2%
Female (N=790)	93.3%	61.7%	92.3%
Chi sq-value, p-value	36.0, <.001	6.9, .01	26.3, <.001

Table 3: Association between Exercise Exposure and primary Violence Related Behavior outcomes by Sex

	Female OR [95% C.I]			Male OR [95% C.I]		
	Not carrying a weapon	Not in a fight	Not in a gang	Not carrying a weapon	Not in a fight	Not in a gang
Exercise frequency	1.7 [0.9, 3.4]	1.3 [0.9, 1.9]	2.9[1.6,5.2]	1.0[0.7,1.6]	1.5[1.1,2.0]	1.2[0.8,1.9]
Sit-ups	2.6[1.4,4.8]	1.3[0.9,1.8]	2.5[1.4,4.6]	1.3[0.8,1.9]	1.4[1.0,2.0]	0.8[0.5,1.3]
Running	2.4[1.2,4.9]	1.5[0.9,2.3]	2.3[1.2,4.6]	0.8[0.4,1.4]	1.2[0.8,1.8]	1.0[0.6,1.8]
Team	2.0[1.1,3.6]	1.95[1.4,2.7]	2.6[1.5,4.4]	1.6[1.0,2.4]	1.7[1.2,2.4]	1.3[0.8,1.9]

Bold denotes statistical significance at $p < .05$

protective effect against violence associated behaviors for team sports in females, and a similar effect in males for one violence associated behavior (fighting) but approaching significance in the other two (using a weapon, being involved in a gang), the implementation of team sports in neighborhoods is to be considered.

This study is limited by being cross sectional and cannot therefore prove direction of effect. The population is a convenience sample primarily of Latino ethnicity and limited to young males and females enrolled in New York City public high schools, which is not representative of the entire population, thus compromising generalizability. Furthermore, socioeconomic status and other potential unmeasured confounding factors were not addressed in the questionnaire. The questionnaire included no adequate measure of community violence exposure, making it difficult to ascertain the influence of the external environment on individual behavior. The variables “Missing school because you were afraid” and “being threatened or injured with a weapon” were poor markers for community violence in that they did not specify if violence was a reason why you missed school or the nature of the threat and the impact it had on the individual. Therefore, it is unclear the role that unmeasured factors may be playing on the findings observed in this study. In addition, behaviors were self-reported with no objective measures to confirm.

Given the potential importance of the findings to developing interventions and the limitations of this cross sectional study, future longitudinal or prospective studies are needed to assess the relationship between exercise and violence related behaviors and potentially evaluating the effect of exercise interventions. These studies can include objective measures for both the exposure and outcome to validate self-reported behaviors. For example, an improved measure for exercise exposure may include a designed community or school based exercise intervention where attendance/participation can be monitored. Similarly, the outcome of violence related behaviors can be confirmed by school behavior, parental reports, police and hospital records. Future cross sectional studies in similar urban populations with larger sample sizes and additional multilevel analysis for community violence exposure and other potential confounders would also be beneficial to determine if the differential association by sex observed here can be replicated. If replicated, these findings would strengthen the need for targeted interventions in adolescent females. However, if the use of larger sample sizes

results in similar protective findings in both males and females, it would strengthen the need for interventions involving both sexes.

Nonetheless, our findings suggest that exercising regularly is associated with decreased involvement in violence related behaviors in adolescent girls, benefits that extend beyond the well-documented effect on decreased rates of obesity and its related comorbidities. In adolescent boys regular exercise was only modestly protective against being in a fight but not the other outcomes.

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